

THE CALIFORNIA WATER AND ENERGY SYSTEM: AN APPROACH FOR ADDRESSING FUTURE CRISES

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RESEARCH OBJECTIVES

The purpose of this fundamental-climate-science, applied-hydrology and economics project is to better understand how natural processes and human intervention interact to influence California's water supply, and the sensitivity of this system to potential disruptions.

Our research objectives are to: (1) quantify the climate drivers impacting mountain front recharge, snowmelt runoff, and net infiltration in the Sierra Nevada and Central Valley; (2) investigate the sensitivity of the water table to these inputs and to pumping with-drawals; (3) adapt existing geophysical logging and monitoring techniques for characterizing the depth distribution of groundwater contaminants; and (4) develop a regional resource management model to demonstrate economic tradeoffs between agricultural and environmental groundwater pumping, incorporating long-term aquifer degradation.

APPROACH

Our research team brings together hydroclimate science, water resources engineering, and economic analyses through drought-sensitivity simulations, groundwater-surface water response studies—at both Central Valley and Merced Basin scales—and studies of the economic impact associated with water supply limitations. Three integrated studies representing climate science, water resources, and economics are merged, resulting in a new type of multidisciplinary analysis. A schematic of this approach is given in Figure 1.

ACCOMPLISHMENTS

Our water-energy system project accomplishments have advanced around three interrelated components. The first component involved coupling climate, land surface, and groundwater models to simulate the water flux and balance. Research focused on the new coupling, testing, and simulations of the LBNL Regional Climate System Model with a state-of-the-art land-surface/shallow subsurface model (NCAR Community Land Model version 3: CLM3), an advanced groundwater-surface water coupling with CLM and the Berkeley Lab Earth Sciences Division

(ESD) TOUGH2 code, and a 104-year atmospheric-land surface simulation with a 25-year drought simulation for the Merced

River Basin Transect. The second component of our work includes salinity with depth characterization at four wetlands sites with difficult-to-access well casings, using an advanced ESD geophysical logging approach. This data has been prepared to calibrate our surface-groundwater code for the Merced Basin.

The third component includes the development of economic models for the value of water supply reliability and the value of groundwater-surface water storage. The water supply reliability model has been calibrated using regional water-source and land value data. A conceptual version of water storage model has been developed using data from the Merced Basin.

SIGNIFICANCE OF FINDINGS

The success of our water-energy system has resulted in a California Energy Commission (CEC) grant for significantly more comprehensive advances in our climate, water, and pricing models, as well as new analyses. This project has resulted in the synthesis of hydrological simulations and economic analysis, representing a new approach for guiding water management under climate change.

RELATED PUBLICATIONS

Brekke, L.N., N.L. Miller, K.E. Bashford, N.W.T. Quinn, and J.H. Dracup, 2004: Climate Change Impacts Uncertainty for the San Joaquin River Basin. *J. Amer. Water Resources Assoc.* 40, 149-164.

ACKNOWLEDGMENTS

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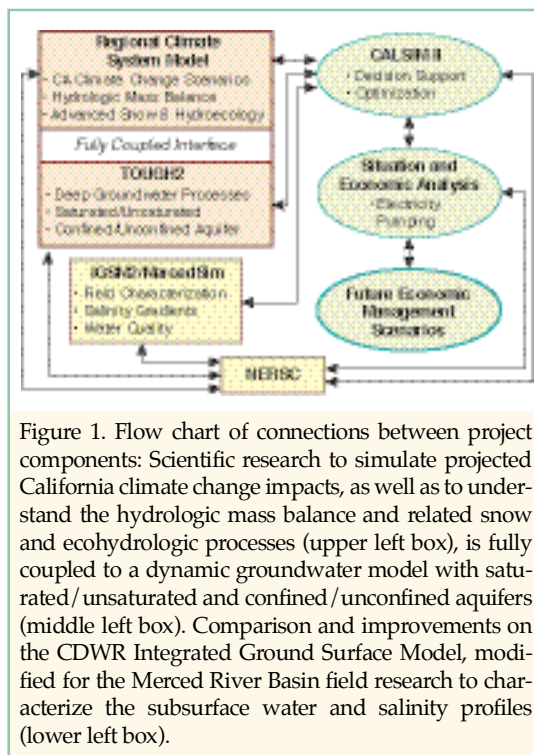


Figure 1. Flow chart of connections between project components: Scientific research to simulate projected California climate change impacts, as well as to understand the hydrologic mass balance and related snow and ecohydrologic processes (upper left box), is fully coupled to a dynamic groundwater model with saturated/unsaturated and confined/unconfined aquifers (middle left box). Comparison and improvements on the CDWR Integrated Ground Surface Model, modified for the Merced River Basin field research to characterize the subsurface water and salinity profiles (lower left box).